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# LEAD BURNING

BY  
THE  
AUTOGENOUS  
PROCESS.

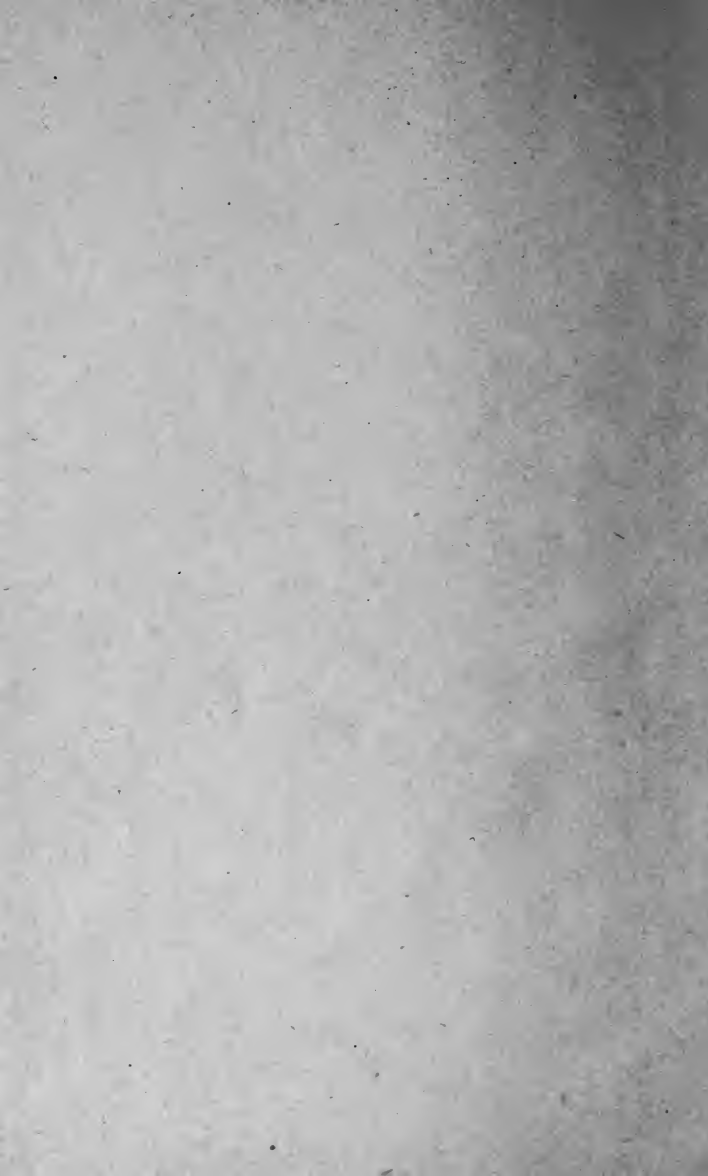
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THEORY AND PRACTICE

. . . OF . . .

# LEAD BURNING

. . . BY THE . . .

## AUTOGENOUS PROCESS

. . . WITH . . .

FULL INSTRUCTIONS TO THE AMATEUR  
IN THE DETAILS OF THE MACHINE AND  
THE MANAGEMENT OF THE GASES, WITH  
VALUABLE SUGGESTIONS AND DIREC-  
TIONS FOR PRACTICE.

. . . BY . . .

AN EXPERT.

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PITTSBURGH, PA., 1892.

By H. H. H.  
J. J. J.  
B. B. B.

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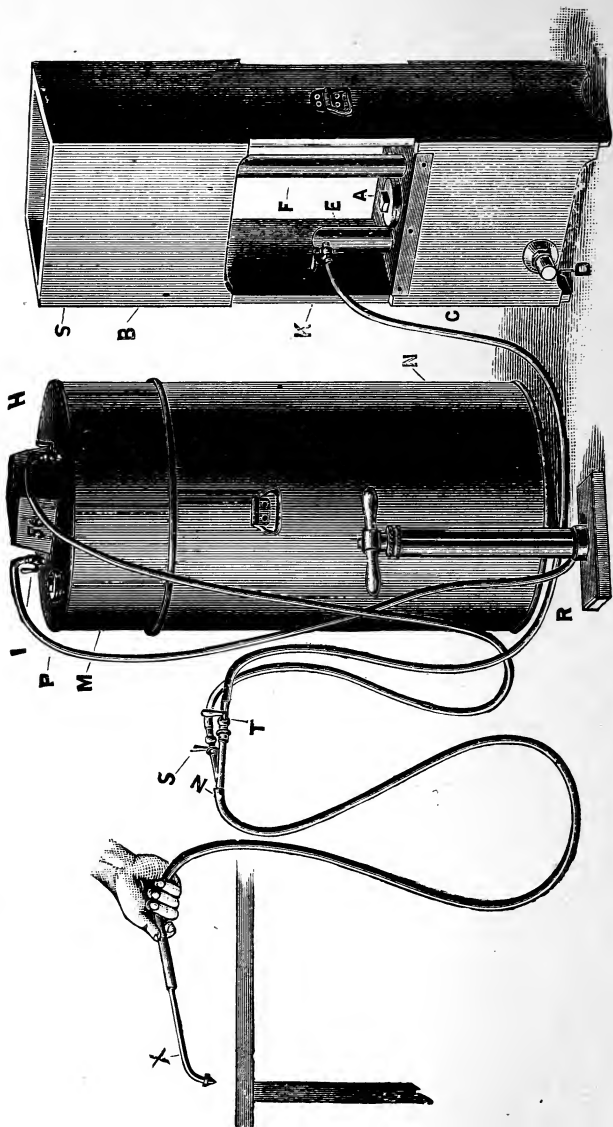


FIG. 1.

## Lead Burning.

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**L**EAD BURNING or the joining or uniting of separate pieces of sheet lead, or lead pipe, by the autogenous process, is beyond doubt of considerable antiquity.

In the year 1801, Robert Hare, M. D., Professor of Chemistry in the University of Pennsylvania, observed that a jet of hydrogen, when inflamed with atmospheric air—of which only one-fifth is oxygen—was productive of a heat of pre-eminent intensity; was led to infer that in combining with pure oxygen—the gas in question—a temperature at least five times as great ought to be produced.

Experiments made during late years by skillful scientists have shown that the heat produced by the combustion of pure hydrogen and oxygen gases, although much more intense, was not anything near five times as great as that produced by using the atmospheric air instead of pure oxygen.

The result of this observation led Dr. Hare to make extensive experiments — extending through a series of years—in the construction of an apparatus to manage and control a mixture of hydrogen and oxygen gases, with a view to use the same for the reduction of platinum.

A full description of the apparatus and experiments was published in the Journal of the Franklin Institute in the year 1847.

The difference between the oxy-hydrogen blow-pipe of Dr. Hare, and the æro-hydrogen blow-pipe, that we bring it to the attention of our readers is: In the former pure oxygen and hydrogen gases are mixed in the exact proportions of two volumes of hydrogen gas, to one volume of oxygen gas; these proportions of gases, when combined under pressure, constitute water, and when the combined gases are burnt through a jet, under pressure, they evolve the most intense heat yet produced.

(It is remarkable that oxygen gas, the presence of which is necessary before the phenomenon of burning can take place, and hydrogen gas, that burns with a pale blue flame,

the combination of these two gases forms water, which is the opposing element of fire.)

In the latter or aero-hydrogen blow-pipe apparatus, slightly impure hydrogen gas in combination with the atmosphere, under pressure, in the proportions of two volumes of hydrogen gas to one volume of atmospheric air, is found to be most economical and efficient for all the purposes of lead burning.

The aero-hydrogen apparatus is supposed to have been introduced in France, and adapted to the burning of lead by Count de Richmont, about the year 1830. A machine of the same construction was patented in England by Luke Herbert, in the year 1838.

It is evident that the art of lead burning is exceedingly old, and yet the machine and process is practical and efficient for the purpose intended.

It is singular that the knowledge and use of the autogenous soldering process, although introduced over fifty years ago, is still confined to a few expert lead workers, whose principle business consists in the erection of leaden

vessels and chambers for use in manufacturing sulphuric acid, and in the lining of agitators and tanks with lead, in the various processes of refining petroleum oil and for other chemical purposes.

We think the reason for this state of affairs is, that practical working machines, built by experienced makers, have not been offered to the trade.

It is necessary to have a burning machine and to know how to use it in order to make a new machine, and if turned out by any but an expert are likely to prove complicated, ineffective and dangerous.

Another reason is, that the few experts pursuing this branch of the plumbing trade consider the process of lead burning as a trade secret and are not overly anxious to impart knowledge to their fellow craftsmen.

The possession of a lead burning machine does not, by any means, make a lead burner of the amateur.

The plumber never forgets the amount of practice and time he expended in learning how

to wipe a solder joint; there is a cunning or sleight-of-hand about it that cannot be taught a pupil by word of mouth, but can only be acquired by observation and practice. So it is with lead burning, after much practice, the blow pipe becomes your servant, and it is as easily managed as the plumber's wiping cloth in making a solder joint.

The secret once learned stays with you always.

We can hardly blame the expert at lead burning for withholding the secret he prizes so highly, and by reason of his knowledge thereof, holds a profitable position.

It is well that the workman understand the nature and properties of the elements by means of which he seeks to obtain certain results. We will therefore examine in detail the peculiar properties of Hydrogen and Oxygen, and the means by which these simple elements are controlled and made available for the purpose of autogenous soldering or uniting of separate pieces of lead (Per. Se.) without the use of the usual tin solder.

## Hydrogen.

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**H**YDROGEN is the lightest known form of matter. Its equivalent combining, or atomic weight, is below that of all other known substances and is represented in chemistry by the symbol  $H_1$ .

Hydrogen is an incondensable æriform fluid. It is not absorbable by water, has no taste, and when pure is inodorous, but it usually has a slight disagreeable smell. Hydrogen is recognized as a simple element and the most combustible body in nature, and contains the greatest number of heat units.

Hydrogen gas for our purpose is obtained by the action of commercial zinc upon diluted sulphuric acid. Pure zinc is very slowly acted on by dilute sulphuric acid. We sometimes find commercial zinc so pure as to yield hydrogen very tardily. The impurities of hydrogen,

derived from the zinc of commerce, consists of carbon and traces of sulphur and arsenic. These impurities do not interfere to any great extent in the use of the hydrogen gas for our purpose.

## Oxygen.

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XYGEN is more abundantly diffused throughout nature than any other elementary body. It forms eight-ninths of the weight of water and one-fifth of the weight of the atmosphere and a large relative proportion of the mineral bodies which form the solid matter of the globe.

It is also an element of all organized bodies, both animal and vegetable.

Oxygen gas is insipid, colorless and inodorous and permanently elastic under all known pressures and temperatures. It is a powerful supporter of combustion.

## Hydrogen and Oxygen,

Considered together, exhibit many remarkable properties.

Hydrogen, during combustion, combines with eight times its weight of oxygen.

Hydrogen explodes most violently when the mixture of one volume of hydrogen with three volumes of atmospheric air is ignited.

If, instead of a mixture of atmospheric air, two volumes of hydrogen and one of pure oxygen be ignited, the explosion is extremely violent.

When two volumes of pure hydrogen gas are mixed with one volume of oxygen gas, and the mixture inflamed in a proper apparatus by the electric spark, the gases totally disappear at the moment of explosion or combination and water equal to the weight of the gases consumed is formed. Combustion, therefore, cannot be regarded as dependent upon any peculiar

principle or form of matter, but must be regarded as a general result of intense chemical action.

This disposition to explode must not be forgotten in working with the lead burning machine.

The introduction of atmospheric air into the hydrogen flame, issuing from a blow-pipe jet, exhibits two distinct figures: the *internal* flame, which is conical, blue, and well defined, at the apex of which the most intense degree of heat is evolved, this is known as the deoxidizing or reducing flame; the *external* flame is red, vague and undetermined and of inferior temperature to the former, and known as the oxidizing flame.

It may be observed that the hydrogen gas is the combustible and the oxygen contained in the atmospheric air the supporter of combustion.

The quantity of atmospheric air that contains the exact proportion of oxygen, which, if chemically combined with the hydrogen, would

produce water, evolves the most intense heat from any given quantity of hydrogen gas issuing from the blow-pipe jet.

The lead burner's flame, when skillfully adjusted to the exact volumes of hydrogen gas and air, will show moisture on the lead seam slightly in advance of the jet. This is caused by the chemical combination of portions of the burning gases.

The terms oxidizement and oxidation imply the combination of oxygen with bodies, and its abstraction or separation is deoxidizement or reduction.

All elementary substances are susceptible of oxidizement, and most of them at certain temperatures, with the evolution of heat and light; these are, in common language, termed combustible or inflammable bodies; when a substance is saturated with oxygen it becomes incombustible; that is, incapable of entering into further combination with oxygen. An excess of

atmospheric air or oxygen forced under pressure into ignited hydrogen gas, issuing from a jet, will extinguish the flame.

The point to be recognized and utilized by the lead burner is to keep the deoxidizing flame only on the work to be done.

## Apparatus.

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**N**UMEROUS methods and machines of various designs have been used during the past fifty years to control and adapt the mixed hydrogen and oxygen gases to the purposes of the lead burner, many of which were unnecessarily complicated and some highly dangerous.

The want of a simple, safe, practical machine and full instructions how to use the same, has prevented the plumbing trade generally from taking advantage of and profiting by this quick, cheap way of soldering or joining lead without solder.

We now give the reader a full and clear description of a simple, safe and practical apparatus for controlling and adapting the mixed gases for soldering lead joints.

It seems to us that it would be profitable for every plumber to have a Lead Burning Machine in his shop, properly charged, ready for use.

It would certainly save its cost in tin solder during the year.

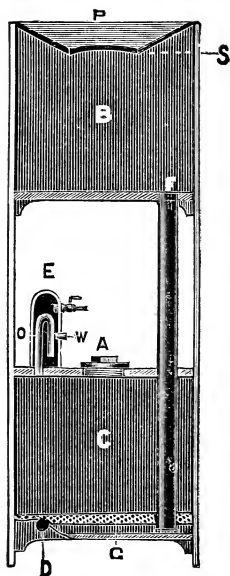


FIG. 2.

## HYDROGEN GAS GENERATOR.

## Hydrogen Gas Generator.

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**T**HIS consists of the gas generating chamber, *C*, Fig. 2. The copper perforated tray, *G*. The inlet and exit acidulated water supply pipe, *F*. The acidulated water reservoir, *B*. The brass trap screw or inlet, *A*, to the gas generating chamber, *C*. Safety chamber, *E*. The fire-trap pipe, *O*. Hydrogen cock. *K*. And cleaning out or drain plug, *D*. Charging inlet, *P*.

On receipt of a Hydrogen Gas Generator from the maker, do not fail to properly test the same, to prove that it is perfectly air tight before introducing the gas generating charge of sulphuric acid.

This can be done in the following manner: Close the hydrogen cock "*K*," examine the cap of the drain vent "*D*," and see that the washer contained therein has a tight bearing on

the male end of the drain plug, screw same up tight. Through the inlet or trap-screw "A," introduce and distribute regularly over the perforated tray "G," 20 to 25 pounds of commercial spelter, broken in lumps of from one inch to two inches in diameter, the idea being to have all the zinc surface possible to act on the acidulated water, but not to have any small particles of zinc that would fall through the holes in the perforated tray "G."

Examine carefully the leaden washer on the trap-screw "A," as it must make a gas-tight joint. A small quantity of tallow will assist in making a tight bearing. Screw the plug up tight

You now have presumably a tight gas generating compartment containing the charge of zinc, from the action of which, on the acidulated water, we propose to generate hydrogen gas.

It will not, however, do to presume or take for granted the tightness of the gas chamber. In working with hydrogen gas, it must be known to a certainty that the gas cannot escape,

except through the outlet or regulating cock "K." We therefore recommend the amateur not to take any chances of a leak of hydrogen gas, but to make a certain test for the tightness of the gas generating chamber, by means of plain water and atmospheric air.

Proceed as follows: Open the hydrogen cock "K," pour into the opening "P" of the acidulated water reservoir "B" plain water, until the water shows itself or spurts out of the hydrogen gas cock "K."

This operation proves that the generating chamber "C" and safety chamber "E" is completely filled with plain water.

Now connect the air-pump "R" to the hydrogen cock "K," by means of the six-foot piece of rubber tubing that belongs to and comes with the air-pump.

About forty strokes of the air-pump will fill the gas chamber "C" with atmospheric air, and drive the water out of the gas generating chamber "C" through the pipe "F" into the reservoir chamber "B," this water will stand about on the line "S;" a continued working of

the air-pump will only blow the excess of air up through the water in the supply pipe "F" and reservoir "B," and escape through the opening or inlet "P," in puffs or blows, keeping the water boiling or in a state of ebullition until the pumping of air into the generator ceases; the water will then quietly settle at the line "S" in the reservoir chamber "B" if all be tight.

Now, shut the hydrogen cock "K" and let the gas generator stand for at least one hour. If there is the slightest leak of atmospheric air, it will be known by the water in the reservoir "B" receding, and if sufficient time is given the water will again fill the generating chamber "C."

There is nothing to be done but to find the leak, and, in most cases, this will be found in the washer of the trap-screw "A."

The expert lead burner has no trouble in making his machine tight.

The amateur will learn by experience the penetrating qualities of hydrogen gas and soon be able to keep a tight gas generating chamber

and so guard against explosions by the accidental igniting of the escaping hydrogen gas.

Having proved the hydrogen gas generator to be perfectly air tight by the plain water standing steadily at the line "S," in the acidulated water reservoir "B," we proceed to find, by means of plain water, the exact fluid capacity of the generator, or, in other words, the exact quantity of fluid that can be used as a working charge when the acidulated water is used.

As the generator now stands, we have pumped the chamber "C" full of atmospheric air, forcing out the plain water into the reservoir "B," any excess of air by continued pumping escapes through the opening "P." The quantity of water now in the generator is its full working charge of fluid that the generator is capable of containing.

This point must be carefully noted, as it would be extremely troublesome to the operator, should he overcharge the generator with acidulated fluid.

If this quantity of fluid is increased in actual practice, the machine will overflow or

blow at "P." If a less quantity of fluid is used the full capacity of the gas generator will not be available. It is, therefore, of importance to the lead burner to know the exact quantity of the water and acid required to obtain the best results from the generator.

For the purpose of recording for use, the exact quantity of the fluid charge, take the machine as it now stands, with the plain water standing in the reservoir chamber "B," at the line "S," open the hydrogen cock "K" and allow all the air to escape. Then unscrew the cap from the drain outlet "D," and collect the escaping water.

The quantity of water now collected is the full fluid capacity, or the quantity of the full working charge of the gas machine, and when charging the machine for active work in generating hydrogen gas with water and sulphuric acid, the combined quantity of the water and acid must not exceed the total quantity of water now collected from the machine.

From the water thus taken from the generator, discard or throw away one-sixth part,

the remaining five sixths pour into the reservoir "B," after having shut the hydrogen cock "K," and tightened up the vent or drain plug "D."

Now take of commercial sulphuric acid, a quantity equal to the water thrown away, or the one-sixth part of the full fluid capacity of the gas generator and carefully pour the acid into the opening "P" of the reservoir chamber "B."

The immediate results will be the evolution of heat by the condensation of the sulphuric acid and water, the acid sours and penetrates every portion of the water. This combination of sulphuric acid and water is acted on by the zinc, which liberates hydrogen gas from the water; this gas, by reason of its lightness, rises to the top of the chamber "C," and, as it accumulates pressure, drives the acidulated water away from the zinc and into the reservoir "B," thus causing the further production of hydrogen gas to cease.

The hydrogen gas generator is now fully charged and ready to supply hydrogen gas at the call of the workman, as desired.

The directions given will enable the amateur to determine the exact quantity of the working acidulated fluid charge for a hydrogen gas generator of any capacity.

The explicit directions are given for the reason that the writer has known of amateurs who have been deterred from persevering in their experiments in lead burning, on account of the difficulty they experienced in obtaining full command of the hydrogen gas generator.

As before stated, the pressure of the gas generated in the chamber "C," immediately after the introduction of the sulphuric acid in the chamber "B," through the opening "P," has driven back the acidulated water through the supply pipe "F," away from the zinc and into the chamber "B," causing the further generation of gas to cease.

The attention of the workman is called to the fact that the portion of atmospheric air in the chamber "C," before the water charged was introduced in the chamber "B," still remains in the chamber "C," and is mixed with the generated gas.

It is usual for the workman, before attaching the rubber tubing to the hydrogen cock "K," to open the cock "K," and allow the mixed air and gas to escape into the atmosphere, closing the cock "K" the moment the water in the chamber "B" has run down to within about one inch of the bottom of the chamber "B."

The generation of pure hydrogen gas now takes place in the chamber "C," and the acidulated water is again driven back to the reservoir "B," and there remains stationary, at the line "S," until the further generation of gas is required.

In this operation be careful that no light is near, as the mixed air and gas escaping is very explosive.

As the hydrogen gas generator is now fully charged and ready for work, we will next consider the aerometer.

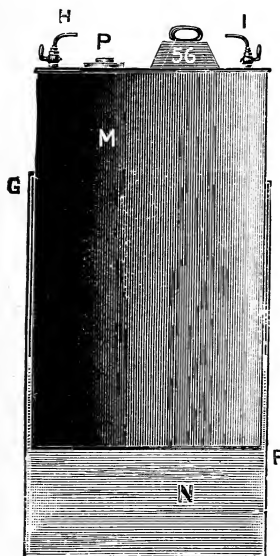


FIG. 3.

AEROMETER.

## Aerometer.

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**T**HE apparatus generally used for supplying atmospheric air to the hydrogen gas blow pipe, will usually be found to be crude and complicated arrangements, doing their work in an intermittent and irregular manner, requiring a helper or assistant's constant labor in keeping up the necessary supply of air.

We describe a simple, compact aerometer, that has been in use and thoroughly tested by many expert lead burners.

It is so arranged as to give a constant and uniform supply of air at any pressure the lead burner desires.

This is a matter of great importance to the workman, as, with a constant, uniform pressure of air, the gas flame can be regulated with an exactness not to be obtained where an irregular, intermittent supply of air is furnished.

Another consideration is, that the time required in keeping the aerometer charged with air, is trifling, as it can be kept charged by the lead burner without the help of an assistant, or if keeping up the air supply be left to the care of a helper, the helper will have an abundance of time to shave and prepare the lead seams, ready for the lead burner.

The aerometer consists of a cylindrical vessel, "N," of galvanized iron, of any desired size, open at the top and closed at the bottom, to which is attached two handles, so as to make the vessel convenient for moving or transportation.

Into this cylindrical vessel, "N," is inserted a similar cylindrical vessel, "M," open at the bottom and closed at the top, and about one inch less in diameter than the cylinder "N."

On the top of vessel, "M," is inserted an inlet air cock, "I," having a union coupling attached.

On top of the vessel "M" and opposite to the inlet air cock "I" is inserted a similar air cock "H," which is used as an outlet air cock.

On top of the cylinder, "M," and near the center of the top is inserted a trap screw "P."

To charge the aerometer, fill the cylinder, "N," one-third full of water. Close the air cocks "H" and "I," tighten up the plug of the trap-screw "P," of the cylinder "M."

Now place the cylinder "M," with its open end down, on the water inside the cylinder "N."

Place a weight of from fifty to one hundred pounds on the top of cylinder "M."

If the air outlet cock, "H," be now opened, the air contained in the aerometer will issue from the cock "H," and at the same time the cylinder "M" will gradually sink until its lower open end comes in contact with the bottom of the cylinder "N."

This action of the cylinder will give a constant supply of air through the cock "H," at a uniform pressure, as long as there be any air in the aerometer.

In practice the supply of air is kept up by the means of the air-pump "R," which is.

attached to the inlet cock "I" by means of a rubber tube. A periodical pumping will keep the aerometer fully charged.

The pressure of the air issuing from the cock "H" is regulated by the amount of weight placed on the top of the cylinder "M."

When the workman ceases operations and desires to remove the aerometer, the trap-screw "P" is slightly loosened, this permits the air to escape and the inside cylinder "M" to be easily withdrawn.

## Adjustment of the Flame.

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**W**E now have the hydrogen gas generator and the aerometer fully charged with gas and air ready for operation.

To utilize and mix the hydrogen gas and air, we proceed as follows: Slip one end of the section of  $\frac{5}{16}$  heavy pure rubber tubing on to the furrowed or roughed tail pipe coupling of the hydrogen cock "K," Fig. 1. Slip the other end of the rubber tube on to the tail of the hydrogen gas regulating cock "T" of the brass mixing fork "Z," connect the air outlet cock "H," of the aerometer, to the air regulating cock "S," of the mixing fork "Z," by means of a similar piece of rubber tubing.

The outlet end of mixing fork "Z" must now be connected by rubber tubing to the brass flame jet holder "X."

The apparatus is now arranged to develop an intense non-oxidizing flame on any spot in

the lead seam the workman desires to direct it. The expert can work all day long, drop by drop, on the seam with this intense flame, which, guided by his skillful hand, melts instantly and cuts off like a knife from the edges of the lead to be joined, a single bead or drop of lead, and guides the drop to its proper place to make a solid homogeneous joint, connecting two pieces of sheet lead so perfectly that it is not possible to discover the point of juncture, and he retires from his day's labor with confidence and knowledge that every drop of lead melted has performed its duty, and constitutes an homogeneous part of a sheet lead seam that he knows to be perfectly tight.

But how is it with the amateur? Let him take the flame from the hands of the expert and try what he can do.

His first attempt to approach the lead seam with the flame, will probably show a beautiful hole burnt through the lead or an ugly oxidized surface that cannot be managed by the flame unless the surface is removed by the shave hook.

It is impossible to convey to the amateur, by means of cold type, the knowledge acquired by the expert, by long experience and practice.

We can, however, assure our amateur that it is as easy to handle the blow pipe flame as it is to wipe a plumber's solder joint.

Patience and Practice will, in a short time, give him that confidence and skill that will enable him to do good work.

The first and most important point is to understand and obtain control of the blow pipe flame.

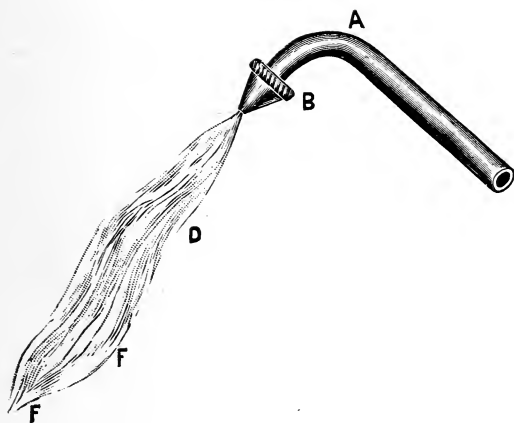


FIG. 4.

HYDROGEN GAS FLAME.

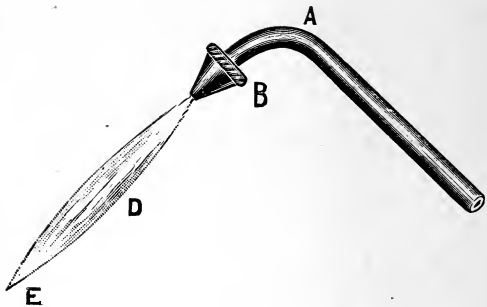


FIG. 5.

WORKING FLAME.

The hydrogen cock "K," at the gas generator, and the air supply cock "H," at the aerometer, being opened full, gives the pressure of both gas and air to the mixing fork "Z."

If the regulating cock "T" be now turned on full, and the issuing gas ignited, we will have a spreading, noisy, brushy, indefinite flame of little heat and of great length. (See Fig. 4.)

Tap the handle of regulating cock "T," gently, so as to cut off the supply of hydrogen gas and reduce this flame to, say three inches in length. Then gently tap the handle of the air cock "S" and admit air to the flame; with the proper quantity of air you will have a rapid darting flame, (Fig. 5), of about one and one-half inches in length, containing an inner pointed cone of blue flame. The apex of this inner cone of blue flame constitutes the non-oxidizing flame, and is the point of greatest heat. The outer flame encircling this blue cone, is vague, undetermined and of a pale reddish color, and is known as the oxidizing flame.

It is well for the learner to study the properties and note the effect of this compound flame.

Clean a portion of a piece of sheet lead by means of a shave hook, in the ordinary way.

Bring the flame down quickly on to the cleaned lead, until a portion of the blue inner flame comes in contact with the lead, and note that the spot of lead melted will present a clear bright surface. This surface will remain bright if the flame is taken away with a quick movement, for the reason that you have melted the lead with the non-oxidizing flame, and removed the flame without allowing the outside or oxidizing flame to come in contact with the melted lead.

Now bring the flame to the cleaned lead at another spot, keeping the apex of the blue cone about a quarter of an inch from the lead. The effect will be that the lead will melt, but much slower than in the former experiment, and when melted will be covered with a gray scum of oxide, in other words the lead has been melted by the oxidizing flame.

Now again, on another clean portion of the lead, bring the flame down quickly and melt a spot of lead with the blue cone flame; this will give you a clean, bright spot of melted

lead; now draw the flame slowly away from the bright melted spot and note that the instant the blue cone leaves the lead, the outer flame acts on and causes the formerly bright spot to become oxidized or covered with a rough, gray scum of oxidized lead.

It is worse than useless to proceed to practice with the flame in joining two pieces of lead until the learner has the proportions of the gas and air adjusted so as to produce the proper flame.

The quantity or length of the flame can be adjusted to suit the thickness of the lead or the position of the work. Should the learner find his flame too large, it is best for him to shut the air regulating cock "S," and then reduce the quantity of hydrogen by gently tapping the handle of the hydrogen cock "T," thereby reducing the quantity of hydrogen gas and shortening the hydrogen flame.

When the desired quantity of gas is obtained, gently tap the handle of the air regulating cock "S," admitting air until the blue inner cone appears in a well defined pointed shape.

## Practice.

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**T**HE learner may now be considered familiar with the non-oxidizing flame, and he may attempt the joining of two pieces of sheet lead, in the manner known as butt seaming. (See Fig. 6.)

The two edges of the sheet lead to be joined are prepared or cleaned by shaving, as shown at "F," the pieces of lead are placed on the bench and the shaved edges brought together.

A seam of this kind is generally made thicker in the seam than the rest of the lead.

The lead required to make this extra thickness in the seam is supplied from a triangular bar of lead, as shown in "E."

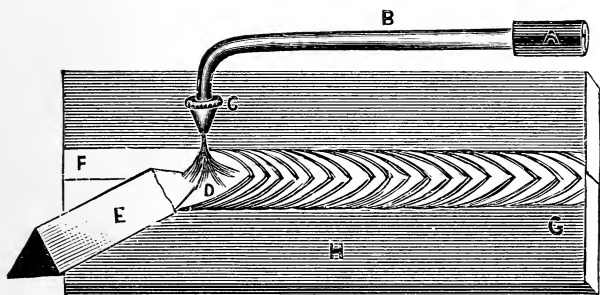


FIG. 6.

FLAT BUTT SEAM.

This seam is started at the point "G" by melting off a drop of lead from the bar "E." This drop of lead, by the attraction of cohesion and directed by the force of the flame, becomes attached to and homogeneous with the melted edges of the cleaned portion of the sheet to be joined.

The making of the seam thus proceeds drop by drop, each drop of lead being directed by and caused to unite with the preceding drop by a peculiar circular motion of the flame directed by the hand of the workman.

The next seam that may be practiced on is known as the flat lap seam.

This is where the edge of one of the sheets to be joined, laps or projects over on to the other sheet, as shown in Fig. 7. The method of making this seam is much the same as the flat butt seam, except that no bar lead is used, the material necessary to make the joint is melted from the front edge of the top sheet.

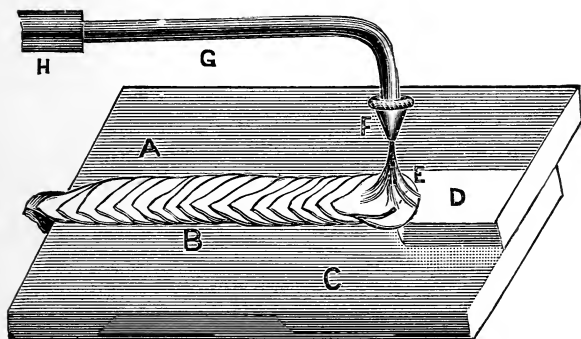


FIG. 7.

FLAT LAP SEAM.

The drop of lead is melted from the front edge at "D," and directed by a quick motion towards "E," and then slightly downward until united with the lower sheet, when the union is made by the lead drop with the lower sheet, the flame is quickly removed in the direction of "D," to melt and carry towards "E," a fresh drop.

By this peculiar motion of the flame in the hands of the workman, the edges of the lead are united drop by drop until the seam is completed.

The edges of the sheet lead to be joined in the horizontal seam, lap in the same manner as in the flat lap seam. The position of the seam, however, makes it more difficult for the learner. This seam has to be made upright, that is, on the side of a wall or tank, and should not be attempted until thoroughly proficient in making the flat lap seam.

The making of a workmanlike horizontal or upright seam, by means of the blow pipe

flame, is considered by many as evidence that the workman thoroughly understands the business of lead burning.

There is no reason why the learner who has become proficient in the making of a flat lap seam, cannot become equally proficient in the making of both the horizontal and upright seams.

By a little practice he acquires the knowledge of the proper amount of lead to cut off, keep hot, and direct to the exact spot required to make a homogeneous junction of the two sheets of lead.

The sheets of lead for the horizontal seam are prepared as shown in Fig. 8. "B" is the upper or back sheet, "A" the lower or front sheet.

The edges of both sheets must be cleaned or shaved. The shaving, however, need not be so wide as for the butt or the flat lap seam.

The flame must be reduced in size, as the melted drop of lead required is much smaller than is used for the flat butt seam.

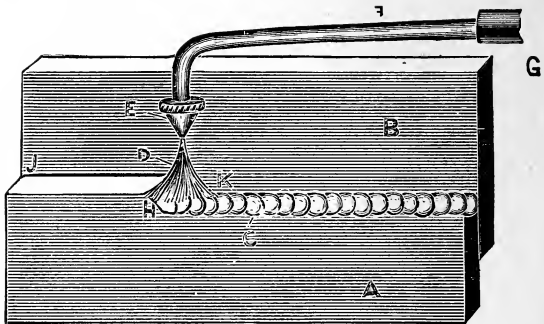


FIG. 8.

HORIZONTAL UPRIGHT LAP SEAM.

The learner can begin to practice the burning of an horizontal seam by fastening the pieces of sheet lead, on which he desires to practice, to a piece of board by a few tacks driven through the sheet lead into the board to keep the sheets "B" and "A," Fig. 8, in place.

We presume he can burn a flat lap seam in a good and workman-like manner, if not, it is useless to attempt this seam.

The learner that can make a fair flat lap seam, will be able to make a fair horizontal seam in four lessons.

1st. Elevate the board on which the sheets for practice, "A" and "B," are fastened, at an angle of twenty-five degrees, see Fig. 9, and it will be found that a small amount of practice will give as good a seam as if made on the flat.

2d. Increase the angle of the practice board to forty-five degrees and the learner will find that, with a little extra care, he can still make the seam.

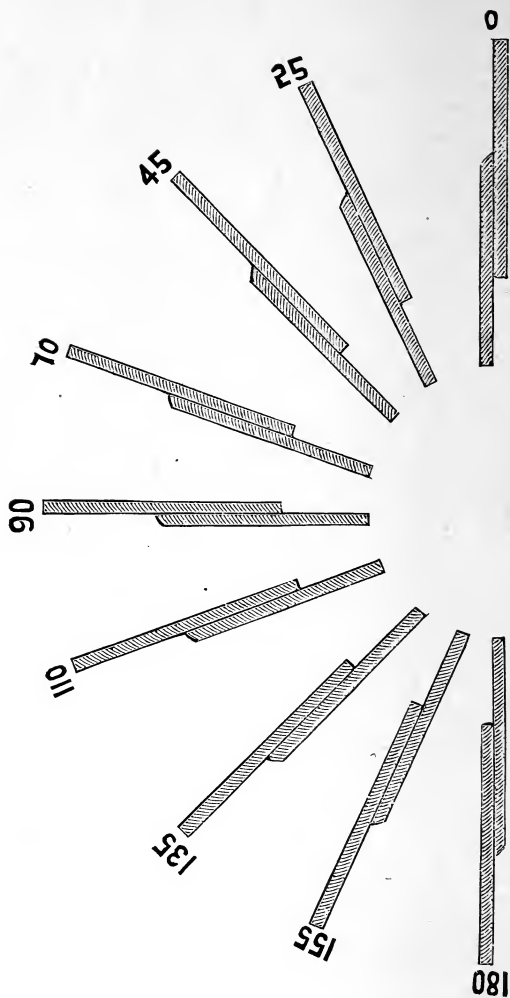


FIG. 9.

ANGLES FOR PRACTICE.

3d. Increase the angle of the practice board to seventy degrees. The experience gained at the angle of forty-five degrees now assists him in the production of a satisfactory seam.

4th. Place the practice board perpendicular or at an angle of ninety degrees, and proceed with the seam as if at seventy degrees.

The results to the learner will be just as good a seam as he made at seventy degrees. As he has been brought by easy stages from the flat to the perpendicular and can, no doubt, now make a workmanlike horizontal seam, he is highly elated to find he can now do easily what he before found impossible, or at least extremely difficult.

The learner now being in high spirits, from his success in making a workmanlike seam, from the flat to the perpendicular, may possibly ask his instructor to give him something more difficult. Should this be the case, we would suggest that he tip his practice board to twenty degrees over the perpendicular and try his horizontal seam at this angle. If successful, continue the declination of the angle of

the practice board, and if he can show a tight, workmanlike horizontal seam, directly over head, the instructor has nothing more to say. He is, indeed, a lead burner.

The perpendicular or straight away upright seam is usually made on the wall or side of a lead chamber or tank, and extends from the floor or bottom of the tank, upwards, or in a direction at right angles to the horizontal seam last explained.

The flame used in making the upright seam is of the same length, and the lead bead, or drop, melted, of the same size as in the making of the horizontal seam.

The learner, having mastered the horizontal seam, will find no trouble in making the upright seam.

There is a slight difference in the direction and run of the melted drop of lead, and the blow-pipe flame strikes the lead at a more acute angle than in the horizontal seam. This position can be seen in Fig. 10.

The flame strikes the edge of the sheet lead "A" at "F," cuts a drop of melted lead,

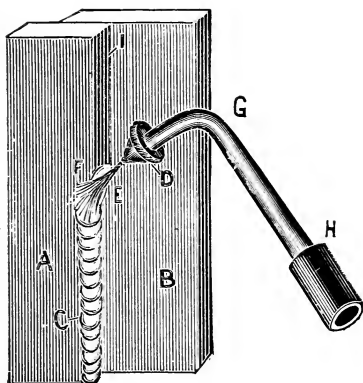


FIG. 10.

UPRIGHT SEAM.

follows and directs the drop by the force of the exuding pencil of gas flame to the point of union, and is instantly removed the moment the juncture is made by the drop of melted lead with the sheet "B."

The seam thus grows in length, drop by drop, under the repeated action of the flame.

The learner has by practice educated his hand and eye to control and place a heavy molten drop of lead at the exact point required to make a perfect homogeneous juncture of two sheets of lead with a portion of its own material.

## Theory of Lead Burning.

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IT IS well to understand the philosophy of the operation of lead burning.

The learner having a knowledge of the non-oxidizing flame, has no trouble in making a flat butt or a flat lap seam, as he finds that the law of gravitation assists him, as the drop of melted lead remains on the flat seam where melted, and submits itself to the laws of adhesion and cohesion, which at once sieze on the drop of melted lead and dispose of it in the exact spot to make a perfect seam. Not so on the horizontal and upright seams. Here we have a disagreement or a fight between physical agents and natural forces. Gravitation says to the melted drop of lead on the upright seam: you are wanted at once, come with me to the center of the earth. Cohesion and adhesion say to the melted drop: we will hold you with all our strength, do not leave us. The expert lead

burner takes advantage of the properties of the molecular forces of cohesion and adhesion, which forces, when combined with the force expended by the flame issuing from the blow pipe jet, are of sufficient strength to hold and manipulate a melted drop of lead of a certain size to the proper point of junction on the upright or horizontal sheet lead seam.

This is the theory of the small bead or lead drop used in the horizontal and upright seam, as compared with the large flow of melted lead used on the flat seams.

The attraction of gravitation is that phenomena in nature that causes all bodies free to move to fall towards the center of the earth. Cohesion is the force that unites two molecules of the same nature.

In large masses of fluids the force of gravity overcomes that of cohesion. Hence, fluids acted on by gravity have no special shape; they take the shape of the vessel in which they are contained. But in smaller masses cohesion gets the upper hand and the fluid presents the spheroidal form.

This is seen in drops of dew on the leaves of plants. It is also seen when fluids are placed on a solid which does not moisten; as for example, mercury on wood.

A number of separate drops of mercury on a plain wood surface, if brought in contact, will cohere in one large globule.

Adhesion is the molecular attraction exerted between bodies in contact. Adhesion takes place between solid bodies and fluids, and can be shown by dipping a glass rod in water; on withdrawing the rod a drop of water will be found suspended to the rod, as the weight of the drop tends to detach it, there must necessarily be some force superior to this weight which maintains it there. This force is the force of adhesion.

This force of adhesion is strongly developed on the lead burner's seam between the cold lead and the melted bead or drop.

From the foregoing the learner will realize that by practice he educates his hand and

eye to guide the forces of nature in producing useful results in the shape of workmanlike seams that show the skill of the expert lead burner.

## After Thoughts.

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**W**E FEEL that our little essay fairly covers the points necessary to enable the learner, by practice, to become an expert lead burner. He will, no doubt, meet with many difficulties, troublesome, simply because not fully understood. Many of these minor difficulties he will escape by commencing with a machine purchased from a reliable manufacturer.

It will never pay him to make his own machine.

Never take a light near the hydrogen gas generator.

When it is desirable to extinguish the flame at the blow-pipe jet, blow it out or jab it out with a quick motion. Then shut the gas cock "K" at the gas generator, and next the air cock "H" at the aerometer.

In charging the hydrogen gas generator, before pouring into the opening "P" the charge of sulphuric acid, see that the safety chamber "E" contains about two inches, in depth, of plain water. This forms a water seal for the fire-trap pipe "O," and extinguishes the flame should it recede through the jet "X," fork "Z," and hydrogen cock "K."

Some experts make a  $\frac{3}{16}$  inch hole in the outer shell of the safety chamber, at a point (See W Fig. 2.) about two inches above the bottom of the chamber, and insert therein, a small wood plug, and by this means establish a water line in the safety box. The withdrawal of the wooden plug allows surplus water to escape, thus keeping the upper part of the safety box free from water.

It will be observed that if the safety box contained an excess of water, it would be liable to blow over into the rubber tubing and thus give the operator considerable trouble, by interfering with and extinguishing the gas flame at the jet.

It often happens that the jet flame becomes suddenly broken or rugged. This may be caused by a small particle of dirt in the nozzle of the jet, in which case it will be necessary to unscrew the tip or nozzle and burnish the jet-hole by inserting a small plug of hard wood. The hole in the jet for four pound lead should be  $\frac{1}{32}$  inches in diameter. Usually three jets of different sizes are sent with a machine by the manufacturer.

The rubber tubing used should be heavy quarter-inch tubing, so that it will not kink and close off the gas or air. The lengths usually used are two twelve foot lengths, one each to the air and gas, and one six foot length from jet to the fork "Z." Any desired length of rubber tubing may be used to connect the air pump "R," with the aerometer cock "I." A length of six feet is furnished by the manufacturers of the machine.

It often happens that it is found convenient to have a length of hose sufficient to extend from the aerometer into the tank on

which the workman is employed. In this case the air supply can be kept up by the workman without leaving the tank.

It sometimes happens that if the gas generator be working very hot that moisture condenses in the rubber tubing, passes through jet, and puts out the flame, making it necessary for the workman to cease operations, detach the tubing, and blow out the water.

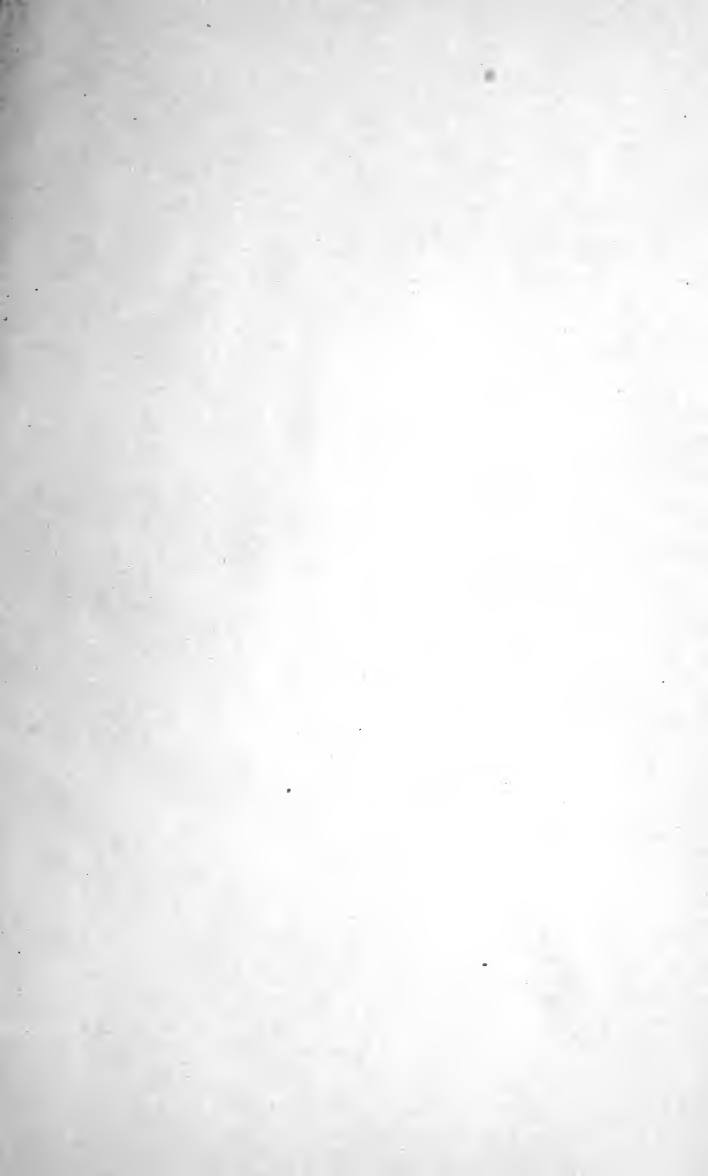
At the close of the day's work, the rubber tubing should be detached from the connections of the machine and suspended from a hook in such a position as to allow the water to drain out during the night.

A proper proportioned gas generator should, if properly charged, furnish a constant supply of hydrogen gas to the workman for a period of ten hours, and should do its work quietly and without a blow and with a moderate degree of heat.

When the job is completed, or at the end of the day's work, detach the rubber tubing, open the air cock "K," and let the acidulated charge run down. Open the drain plug

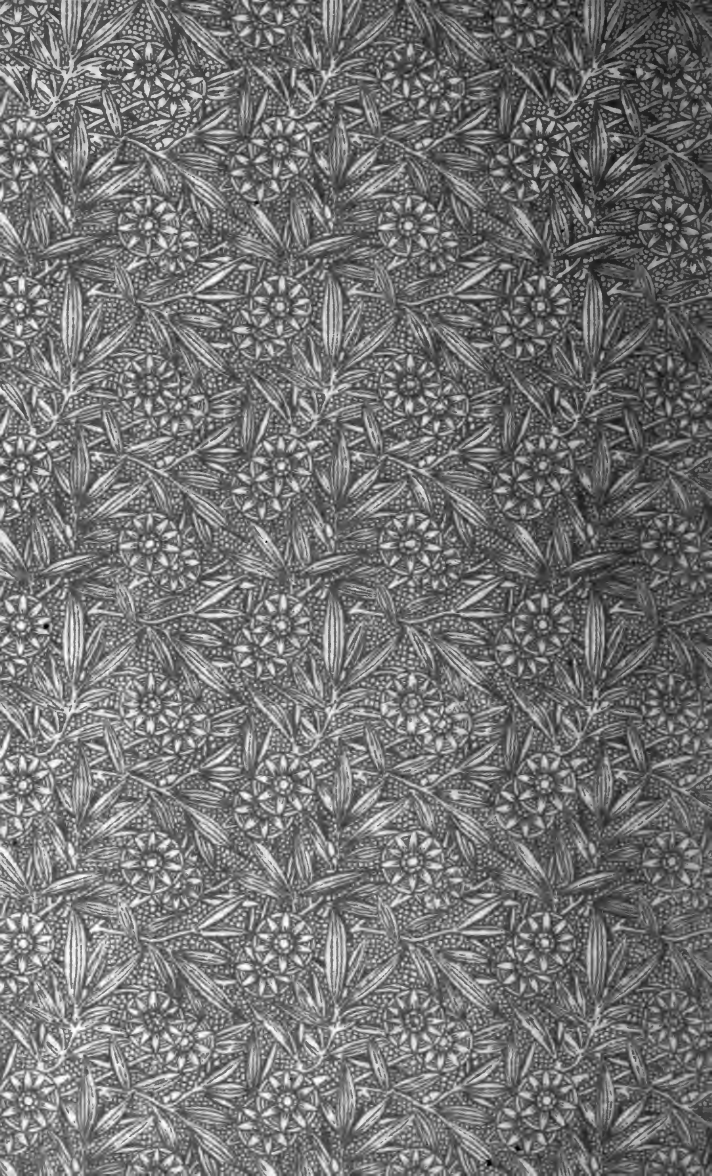
"D" and throw away the fluid contents of the generator. Pour a couple of bucket fulls of clean water through the opening "P," and let the water run out through drain "D." This will clean out the generator and have it ready for the next day's work. Should you quit work and let the saturated acidulated solution stand in the machine, you will find next morning that the machine was clogged or choked by the crystalization of the sulphate of zinc.

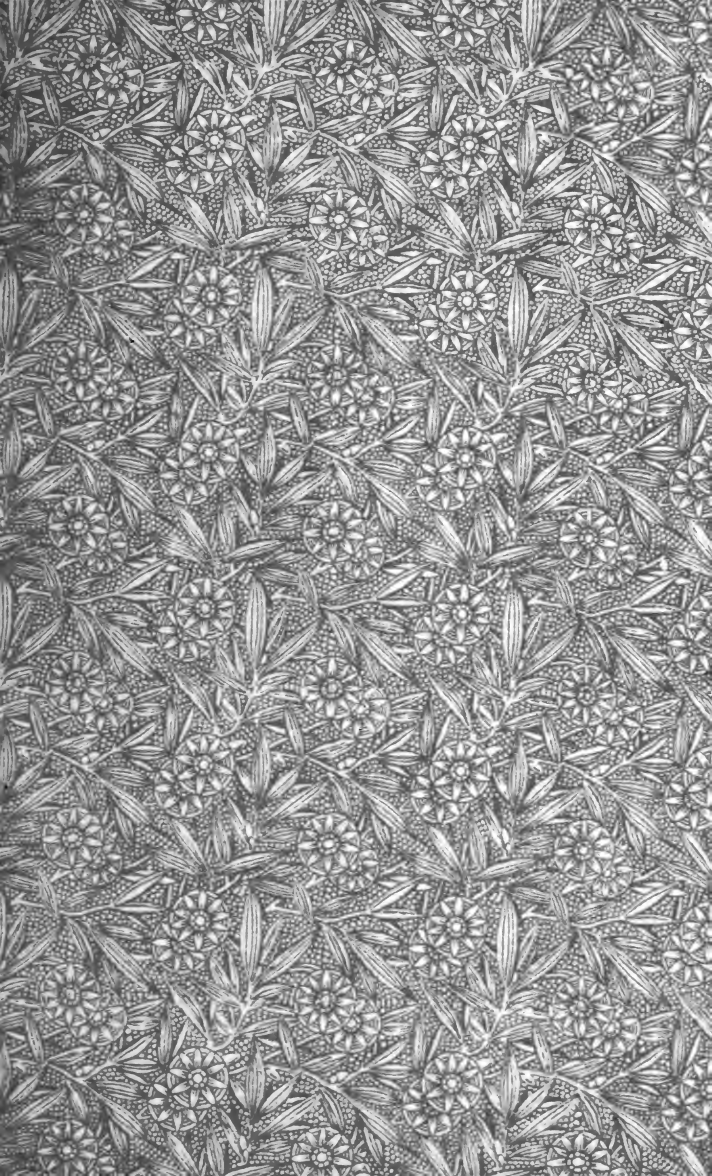












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